ARTHROPOD ASSOCIATES OF PLANTS AT THE NEVADA TEST SITE*

By

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INTRODUCTION

This study was made to determine plant-arthropod associations related to the predominant plants in several plant communities at the Nevada Test Site. In our arthropod studies, special emphasis has been directed to the identification of kinds, relative numbers, seasonal incidence and ecological distribution relative to the plant communities as well as individual plant species. These data contribute to the over-all objectives of the ecological studies being conducted by the Brigham Young University Zoology and Entomology Department in cooperation with the U. S. Atomic Energy Commission. These objectives and community designations were reported by Allred, Beck and Jorgensen (1963a).

Ideally the arthropods in this study should have been discussed at the species level. Due to difficulty in obtaining help from taxonomic specialists this was not possible, and we used only the higher taxonomic categories. Nevertheless, we feel that groups of species with similar anatomical, physiological and ecological characteristics may be dealt with collectively. This will provide a basis for further studies on the species level by specialists trained to study such organisms.

In our ecological studies we have collected and preserved thousands of arthropods. Detailed ecological data for each have been recorded. Although some of these organisms may never be studied at the species level, it is expected that most eventually will be so studied and thus vindicate the original effort of making the collections.

METHODS

Plants of eleven species were studied. Each month one plant of each species was taken from a specific area in one of the biotic communities. (For the location of these areas see Table 1.) Each individual plant that was selected was not immediately adjacent to a different species but more or less stood alone.

The following technique was used for each collection. A white canvas cloth was placed on the ground around the plant, snuggly fitting about the base at ground contact (Fig. 1). This was done to collect organisms as they fell from the plant while it was being examined and thus avoid soil and humus contamination by the stem- and leaf-dwelling arthropods. Next was the systematic removal of stems and leaves. These were cut by hand clippers and placed into paper bags (Fig. 2). Specimens and plant debris falling onto the cloth were also placed into the bag containing the stems and leaves. The canvas was then removed, and the surface soil and humus plus the base of the plant and large roots were collected, measured volumetrically and placed in a second bag (Fig. 3). The bags were taken to the laboratory and their contents placed in separate Berlese funnels 18 inches in diameter and 3 feet long (Fig. 4). The funnels were operated for 24 to 36 hours for each collection. Specimens were collected in catch-bottles containing 70 percent alcohol. Specimens in each bottle were sorted to the taxonomic division of Order, and in a few cases the Family. The number of each kind was then determined.

Inasmuch as individual plants varied in size, and the amount of soil and humus taken also varied from plant to plant, corrections for the different volumes were made so that figures used for population analysis would be on a comparative basis. For example, if the total number of arthropods taken from the largest volume of a single plant was 100, then a number of 5 taken from only one-tenth the volume with reference to a different plant was adjusted to 50.

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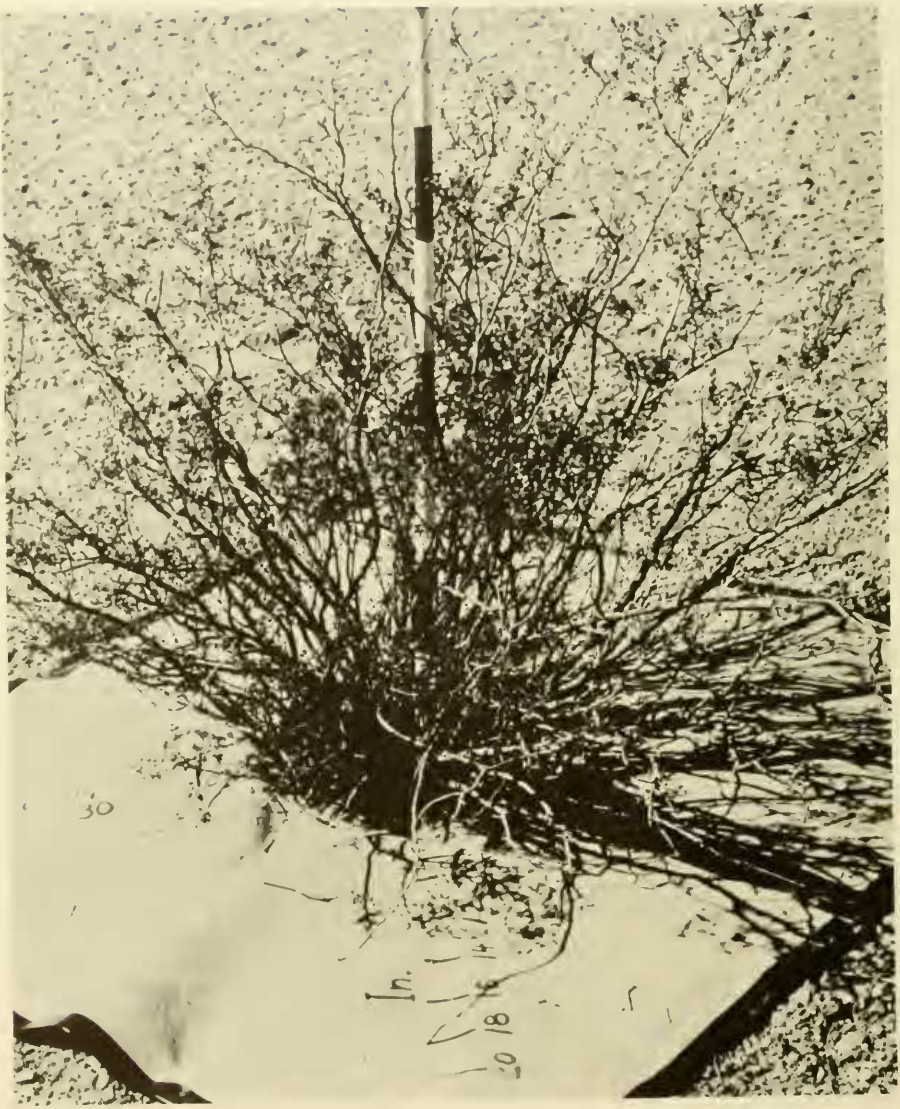

Figure 1. Plant of *Larrea divaricata* showing protective canvas.

Figure 2. Process of cutting plant for transport to the laboratory.

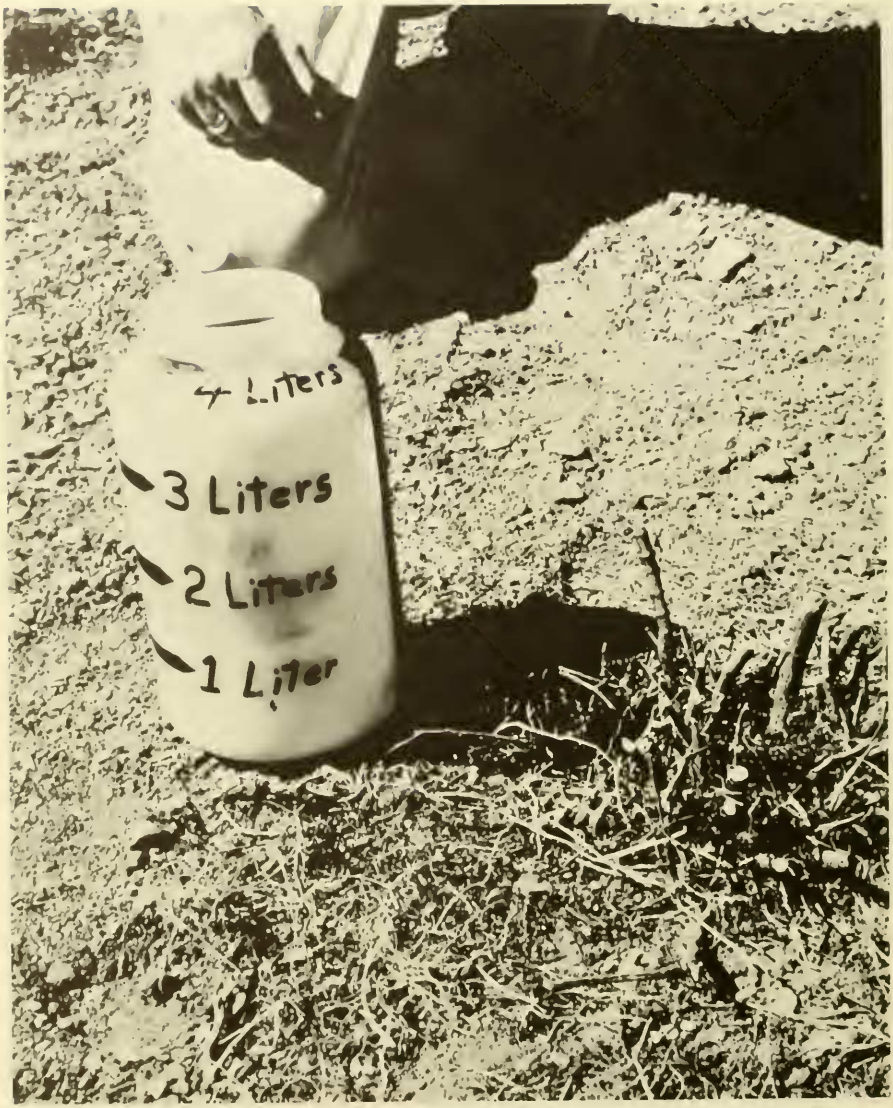

Figure 3. Bottle used to measure volume of base and roots of plant, and humus on ground.

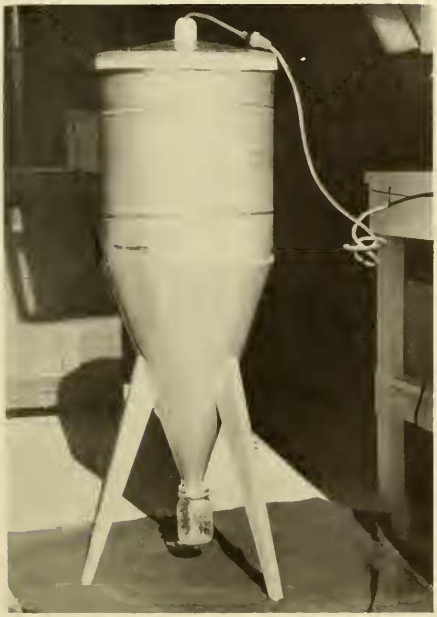

Figure 4. Berlese funnel used for extraction of arthropods.

ARTHROPOD ASSOCIATES

Relative numbers of individuals of each order and some families with their plant associations are shown in Table 2. Figures 5 to 15 show the relative abundance of arthropods on the stems and leaves as compared with the numbers in the soil and humus of each plant. Figures 16 to 46 show the seasonal occurrence of the predominant groups of arthropods relative to each plant species.

Pseudoscorpions
(Pseudoscorpionida)
Figs. 5-15

These arachnids were most commonly associated with *Atriplex confertifolia*, but were also found with *Coleogyne ramosissima*, *Larrea divaricata* and *Lycium* spp. All were taken from the soil and humus. The minimal amounts of moist decaying organic debris under the plants likely is a critical factor affecting the presence of these organisms.

Spiders
(Araneida)
Figs. 5-15

Although not in great numbers, spiders were found associated with all plant species except *Salsola*. They were least abundant with *Kochia*,

Table 1. Plant community and specific localities* of plant collections at the Nevada Test Site.

Atriplex canescens (*Grayia-Lycium* Community, Study 6 D D) - 3.2 miles S of Well 3 B.

Atriplex confertifolia (*Atriplex-Kochia* Community, Study 6 D A) - 0.5 mile S of Well 3 B, thence 0.6 mile E.

Coleogyne ramosissima (*Coleogyne* Community, Study 2 D A) - 11 miles N of Well 3 B on Rainier Mesa road, thence 100 yards S.

Eurotia lanata (*Grayia-Lycium* Community, Study 6 D C) - Environs of Well 3 B.

Grayia spinosa (*Grayia-Lycium* Community, Study 4 D A) - 4.2 miles N of Well 3 B along Rainier Mesa Road, thence 1 mile W.

Kochia americana (*Atriplex-Kochia* Community, Study 6 D B) - 0.5 mile S of Well 3 B, thence 0.6 mile E.

Larrea divaricata (*Larrea-Franseria* Community, Study 5 D A) - 0.3 mile E of Mercury Highway, N of Well 5 B road.

Lycium andersoni (*Grayia-Lycium* Community, Study 4 D B) - 4.2 miles N of Well 3 B along Rainier Mesa Road thence 1 mile W.

Lycium pallidum (*Larrea-Franseria* Community, Study 5 D B) - 1.1 miles E of Mercury Highway, thence 1 mile S of Well 5 B road.

Salsola kali (*Salsola* Community, Study 1 E A) - 150 yard radius, 1320 ft. SE of GZ-1.

Yucca brevifolia (*Coleogyne* Community, Study 6 D E) 4.7 miles S of Well 3 B.

*For mapped localities of the studies (6 D D, etc.) refer to Allred, Beck and Jorgensen (1963b).

Table 2. Relative numbers of individuals of orders and families of arthropods associated with each plant species.

	Plant										
Arthropod Group	Atr can	Atr con	Col ram	Eur lan	Gra spi	Koc ame	Lar div	Lyc and	Lyc pal	Sal kal	Yuc bre
Pseudoscorpionida		12	5				6	5	1		
Araneida	45	22	14	28	18	3	35	16	13		51
Acarina	951	1025	2164	661	1207	1246	1296	704	473	9	373
Collembola	25	23	556	1251	212	259	60	63	57		17
Psocoptera	28	34	9	16	3	10	106	21	2		
Thysanoptera	650	32	388	1853	90	225	674	97	223		17
Hemiptera											
Corimelaenidae					59			4			
Corizidae							1				
Lygaeidae	6						2			2526	
Miridae	119	81		57	77	20	13	19	8	2	17
Nabidae										1	
Pentatomidae										2	
Tingidae	3			87							
Homoptera											
Aphididae	21	51	14	31	5	4					
Cicadellidae	211	101	57	101	10		19	16			
Coccidae	670	2011	1249	1106	274	2303	233	25	82		631
Fulgoridae			1	21		6					
Membracidae				2	1		819				
Psyllidae								3711	4		
Neuroptera	8	17		5	4						
Lepidoptera	55	139	1	23	29	49	44	213	190		5
Coleoptera	204	42	225	150	286	224	196	112	83		665
Hymenoptera											
Bethylidae										1	
Braconidae				4	1						
Ceraphronidae	3	1			1						
Encyrtidae	9		9	13					4		
Eulophidae				9							
Formicidae	4	208	293	9	53		82	4	35	7	
Mymaridae			8						1		
Pteromalidae	4	1	28	19	4		22	13			17
Sclerogibbidae		1									
Tiphiidae	2			2			1				
Diptera	158	121	116	38	112	3	42	122	57		179

and they were most commonly associated with *Yucca* and *Atriplex canescens*. In association with *Atriplex confertifolia*, *Eurotia* and *Yucca* they were found in about equal abundance on the stems and leaves and in the soil and humus. In other plant associations they were more common in the soil and humus.

Mites
(Acarina)

Figs. 5-15, 18, 20, 23, 28, 32, 33, 36, 40, 43, 45

These animals were associated with all the plant species except *Salsola*. They were most commonly found with *Coleogyne*, but were moderately abundant with *Atriplex confertifolia*, *Grayia*, *Kochia* and *Larrea*. With *Coleogyne*, *Eurotia*, *Kochia*, *Larrea* and *Salsola* they were found predominantly on the stems and leaves. With *Yucca* they were about evenly distributed between stems-leaves and soil-humus. In other plant associations they were more common in the soil and humus. The seasonal population peaks of the mites varied considerably with the plant species. Highest populations were not necessarily more common for one month than another except November when peaks occurred with *Atriplex canescens* and *Kochia*.

Spring-tails
(Collembola)
Figs. 5-15, 22, 27, 31, 34

These insects were most abundantly associated with *Eurotia*. They were not found with *Salsola* and occurred least with *Yucca*. With *Atriplex canescens*, *Coleogyne* and *Kochia* they were found more abundantly on the stems and leaves, whereas with *Grayia* and *Lycium pallidum* they were about evenly distributed between stems-leaves and soil-humus. In other associations they were more common in the soil and humus.

Psocids
(Psocoptera)
Figs. 5-15

Psocids were found in small numbers in association with all plant species except *Salsola* and *Yucca*. They were most abundant with *Larrea* and least with *Grayia* and *Lycium pallidum*. They were more abundant on the stems and leaves of *Grayia*, about evenly distributed between stems-leaves and soil-humus with *Atriplex canescens* and *Coleogyne*, and occurred predominantly in the soil and humus with other plants.

Thrips
(Thysanoptera)
Figs. 5-16, 22, 27, 30, 34, 36, 39, 41

Thysanopterans were associated with every plant species studied except *Salsola*. Their occurrence was infrequent with *Yucca* and *Atriplex confertifolia*, and they were most abundant with *Eurotia*. They were commonly found on the stems and leaves except in association with *Atriplex confertifolia* and *Yucca* where they were predominant in the soil and humus. With *Eurotia* they were about evenly distributed between the two locations. Seasonally, highest populations occurred in April with *Kochia*, *Larrea* and *Lycium* spp., and in June with *Eurotia* and *Grayia*.

Bugs
(Hemiptera)
Figs. 5-15, 17, 19, 26, 31, 35, 44

Hemiptera were found associated with every plant species but were rarely taken in association with *Coleogyne* and *Yucca*. Highest numbers occurred with *Salsola*. Insects of the family Miridae were found with all plants except *Coleogyne*. Large numbers with *Salsola* consisted principally of bugs of the family Lygaeidae. Other families were represented only by small numbers of individuals. With *Lycium* spp. the bugs were about evenly distributed between stems-leaves and soil-humus. With *Coleogyne* and *Salsola* they were predominantly in the soil and humus. With other plants they were principally on the stems and leaves. Highest populations for nymphs occurred in March with *Atriplex* spp. and *Kochia*, and for adults in June with *A. canescens* and *Eurotia*.

Aphids, Scale Insects and Relatives
(Homoptera)
Figs. 5-16, 21, 23, 28, 30, 33, 40, 42, 45

These insects were found in association with all plant species studied. They were infrequently associated with *Salsola* but commonly found with *Lycium andersoni*. The majority taken belonged to the family Coccidae, but insects of the families Cicadellidae and Aphididae were present with more than half of the plants. Psyllids were numerous with *L. andersoni*, but were not found with any other plant except for small numbers with *L. pallidum*. With *L. pallidum* and *Yucca* these insects were about evenly distributed between stems-leaves and soil-humus. With all other plants they were more abundant on stems and leaves. Seasonally April was a month when populations were highest with *Grayia*, *Kochia* and *L. pallidum*. May was the peak month with *Atriplex confertifolia* and *L. andersoni*.

Nerve-Winged Insects
(Neuroptera)
Figs. 5-15

These insects were found in small numbers with only four plants. They were predominant on the stems and leaves with *Eurotia* and *Grayia*, and in the soil and humus with *Atriplex* spp.

Butterflies and Moths
(Lepidoptera)
Figs. 5-15, 19, 39, 41

These animals were associated with every plant except *Salsola*, but only few numbers were taken with *Coleogyne* and *Yucca*. They were most abundant in association with *Lycium* spp. They were more frequently associated with soil and humus with *Eurotia* and *L. pallidum*, about evenly distributed between the two areas with *Larrea* and *Lycium andersoni*, and more abundant on stems and leaves of other plants.

Beetles
(Coleoptera)
Figs. 5-15, 18, 24, 29, 35, 37, 38, 42, 46

These were common with all species of plants except *Salsola*, being most abundant with *Yucca*.

With *Larrea* they were about evenly distributed between stems-leaves and soil-humus. With *Lycium pallidum* they were predominantly in the soil and humus, and with other plants they predominated on the stems and leaves. Highest populations of larvae occurred in March with *Eurotia* and *Lycium andersoni*, April with *Kochia* and *Larrea*, and May with *Coleogyne* and *Yucca*. Adults were most abundant in August with *Atriplex canescens*, *Coleogyne* and *Kochia*.

ANTS, BEES, WASPS AND RELATIVES
(Hymenoptera)
Figs. 5-15, 20, 24, 37

These insects were associated with all species of plants except *Kochia*. They were most abundant with *Coleogyne* and least abundant with *Salsola*. Those of the family Formicidae were most common on *Atriplex confertifolia*, *Coleogyne*, *Grayia*, *Larrea*, *Lycium pallidum* and *Salsola*, whereas other families were most common with other plants. With *Lycium andersoni* these insects were about evenly distributed between stems-leaves and soil-humus. With *Atriplex canescens*, *Eurotia* and *Larrea* they were more abundant on stems and leaves, whereas with other plants they were predominant in the soil and humus.

FLIES
(Diptera)
Figs. 5-15, 17, 21, 25, 29, 38, 46

These insects were found with all plant species except *Salsola*, and were relatively rare with *Kochia*. They were most abundant with *Yucca*. They were evenly distributed between stems-leaves and soil-humus with *Coleogyne*, *Larrea* and *Lycium andersoni*. They were more predominant in the soil and humus with *Atriplex* spp., and on the stems and leaves of other plants. Highest numbers of larvae occurred most frequently in February with *Atriplex* spp. and *Yucca*, and in April with *Lycium* spp.

DISCUSSION

The collection techniques and procedures in this study undoubtedly biased our results. Approaching a plant and cutting it into small pieces causes many flying insects to leave before they can be collected. Although plants were not disturbed physically before a canvas was set in place, the approach of the collector may have caused some arthropods to drop to the ground. This is known to be a part of the protective behavior of some organisms. All the collections were made during the daylight hours. Thus, the incidence of nocturnal associates and their distribution on the plant or ground is not known. This may explain in part the predominance of stem and leaf dwellers in the soil and humus under the protective cover of the plant. Climatic changes such as wind, precipitation or cloudiness during the day may also influence the movement of some arthropods.

The Berlese funnel likewise was a selective sampling technique. Some arthropods may be heat tolerant or negatively phototaxic and consequently may not have moved down the funnel into the collecting bottle. Others may have been killed by the heat or were unable to pass through the relatively small screen supporting the plant materials.

Nevertheless, on the basis of the techniques used, the results are indicative of incidence, relative abundance and seasonal occurrence of certain groups of arthropods on the plants sampled. These data may serve as a basis for further studies at the test site dealing with the effects of nuclear testing and radiation on food chains, as well as radionuclide pathways.

LITERATURE CITED

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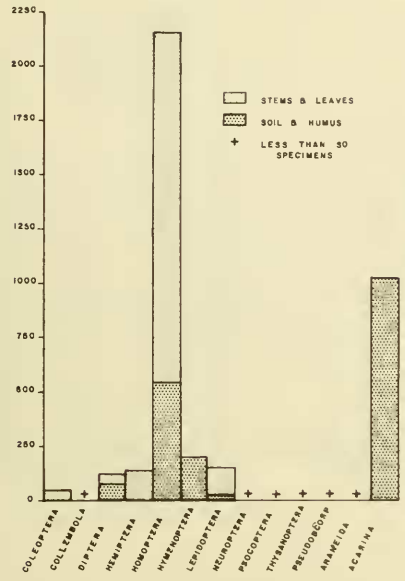

Figure 5. Relative abundance of arthropods associated with *Atriplex canescens*.

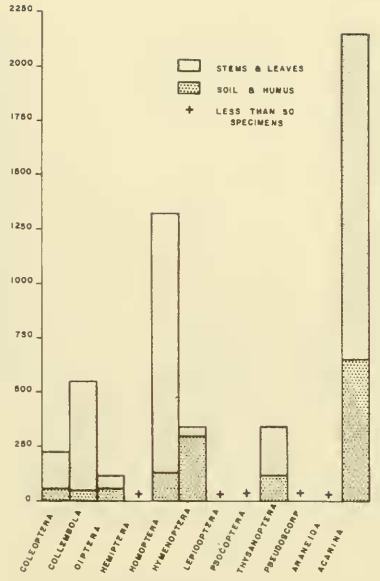

Figure 7. Relative abundance of arthropods associated with *Coleogyne ramosissima*.

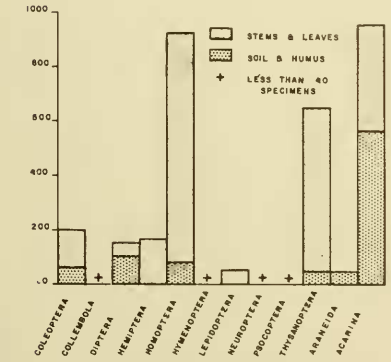

Figure 6. Relative abundance of arthropods associated with *Atriplex confertifolia*.

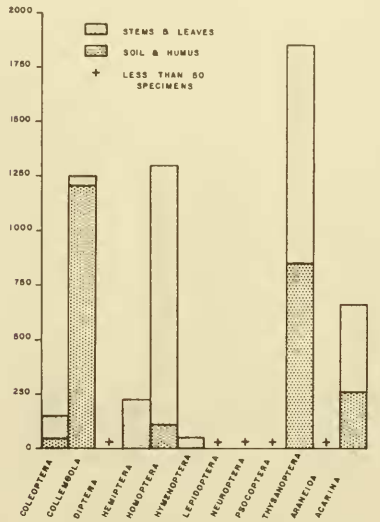

Figure 8. Relative abundance of arthropods associated with *Eurotia lanata*.

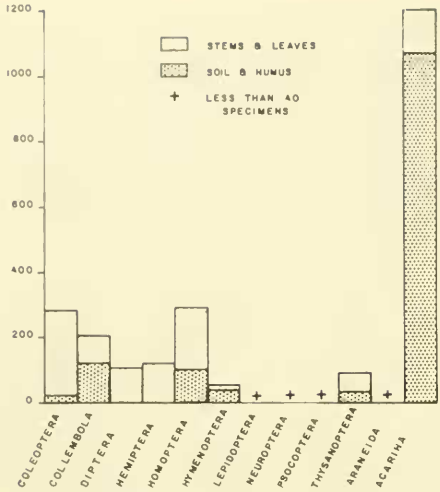

Figure 9. Relative abundance of arthropods associated with *Grayia spinosa*.

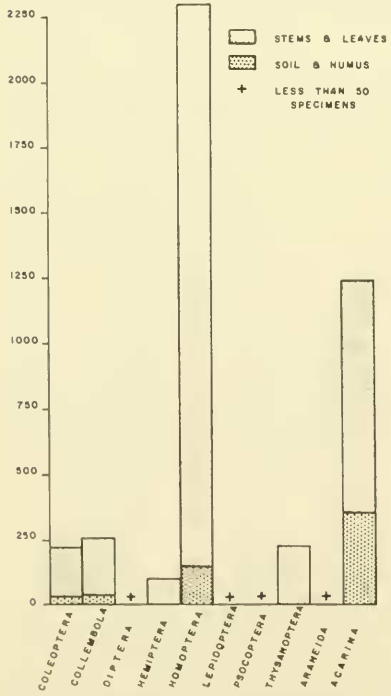

Figure 10. Relative abundance of arthropods associated with *Kochia americana*.

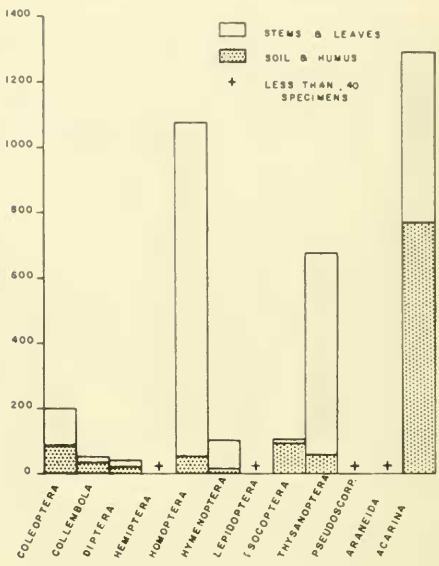

Figure 11. Relative abundance of arthropods associated with *Larrea divaricata*.

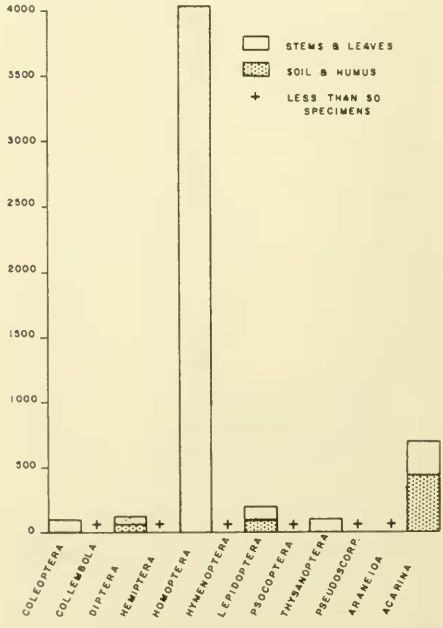

Figure 12. Relative abundance of arthropods associated with *Lycium andersoni*.

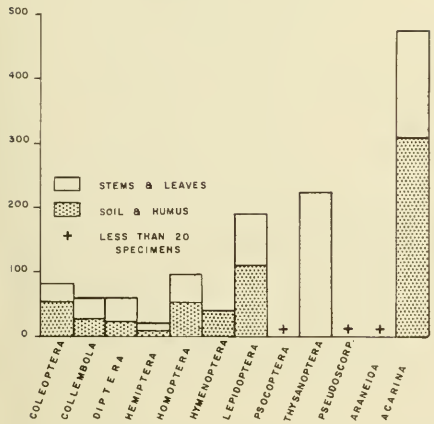

Figure 13. Relative abundance of arthropods associated with *Lycium pallidum*.

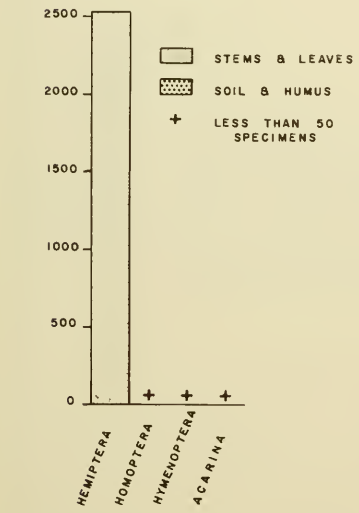

Figure 14. Relative abundance of arthropods associated with *Salsola kali*.

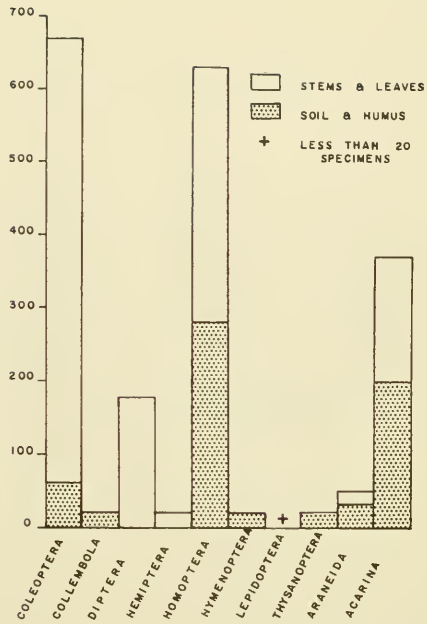

Figure 15. Relative abundance of arthropods associated with *Yucca brevifolia*.

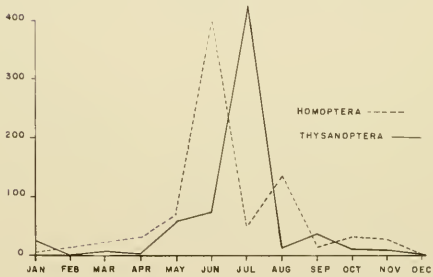

Figure 16. Seasonal occurrence of Homoptera and Thysanoptera on *Atriplex canescens*.

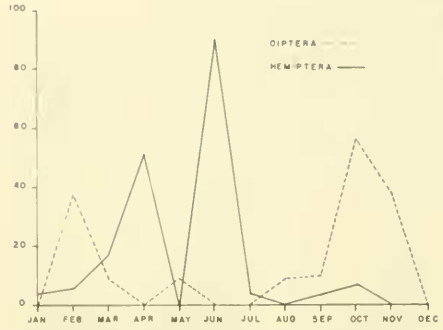

Figure 17. Seasonal occurrence of Diptera and Hemiptera on *Atriplex canescens*.

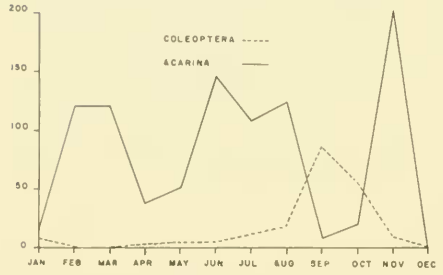

Figure 18. Seasonal occurrence of Coleoptera and Acarina on *Atriplex canescens*.

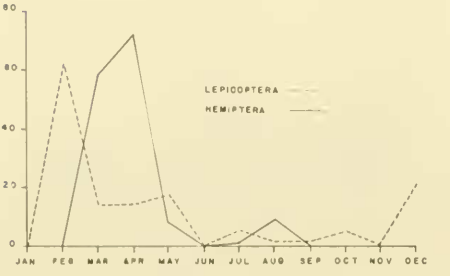

Figure 19. Seasonal occurrence of Lepidoptera and Hemiptera on *Atriplex confertifolia*.

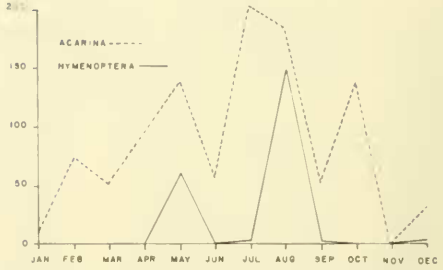

Figure 20. Seasonal occurrence of Acarina and Hymenoptera on *Atriplex confertifolia*.

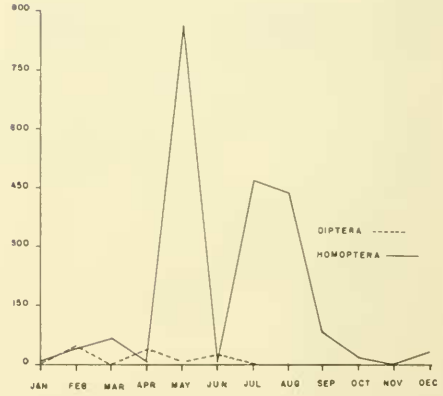

Figure 21. Seasonal occurrence of Diptera and Homoptera on *Atriplex confertifolia*.

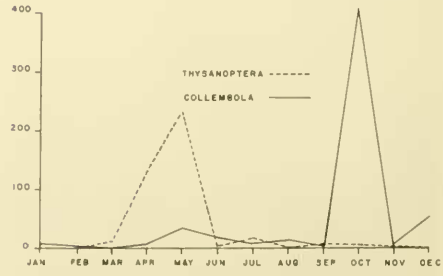

Figure 22. Seasonal occurrence of Thysanoptera and Collembola on *Coleogyne ramosissima*.

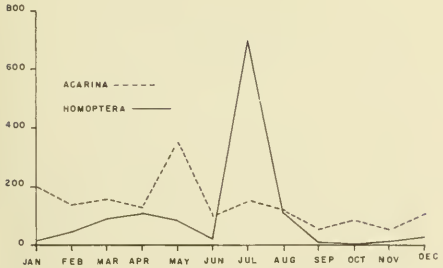

Figure 23. Seasonal occurrence of Acarina and Homoptera on *Coleogyne ramosissima.*

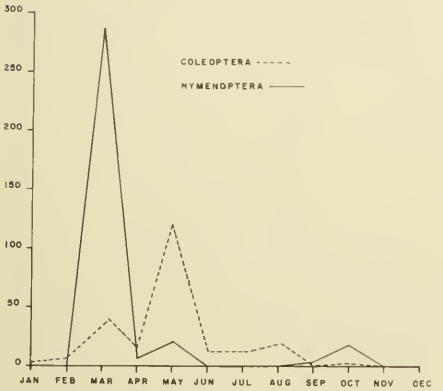

Figure 24. Seasonal occurrence of Coleoptera and Hymenoptera on *Coleogyne ramosissima.*

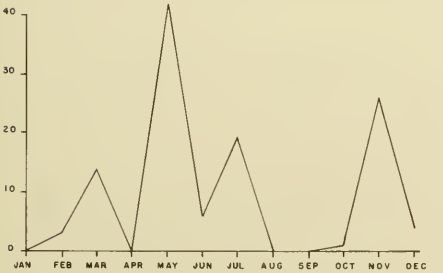

Figure 25. Seasonal occurrence of Diptera on *Coleogyne ramosissima.*

Figure 26. Seasonal occurrence of Hemiptera on *Eurotia lanata.*

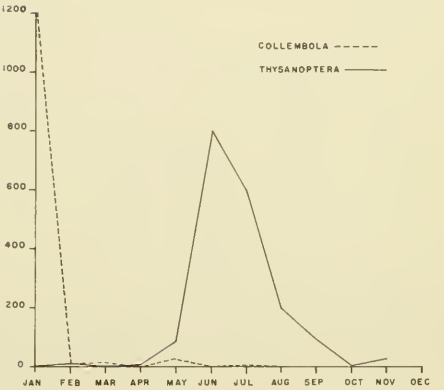

Figure 27. Seasonal occurrence of Collembola and Thysanoptera on *Eurotia lanata.*

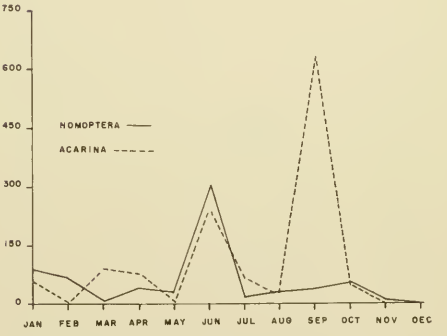

Figure 28. Seasonal occurrence of Homoptera and Acarina on *Eurotia lanata.*

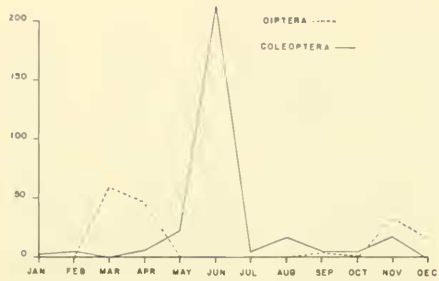

Figure 29. Seasonal occurrence of Diptera and Coleoptera on *Grayia spinosa*.

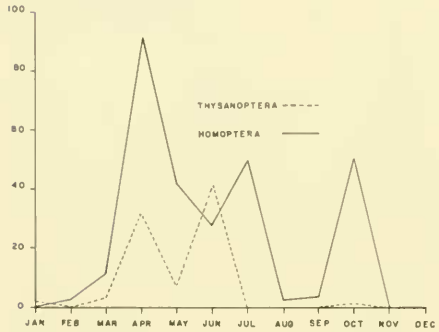

Figure 30. Seasonal occurrence of Thysanoptera and Homoptera on *Grayia spinosa*.

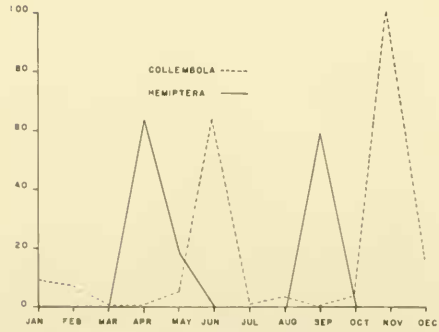

Figure 31. Seasonal occurrence of Collembola and Hemiptera on *Grayia spinosa*.

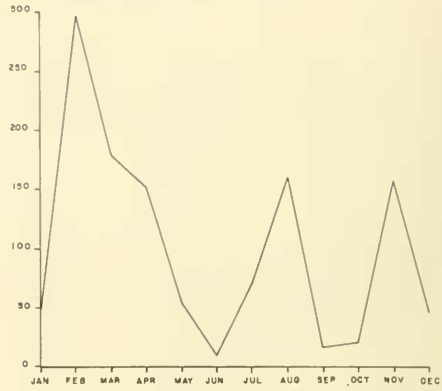

Figure 32. Seasonal occurrence of Acarina on *Grayia spinosa*.

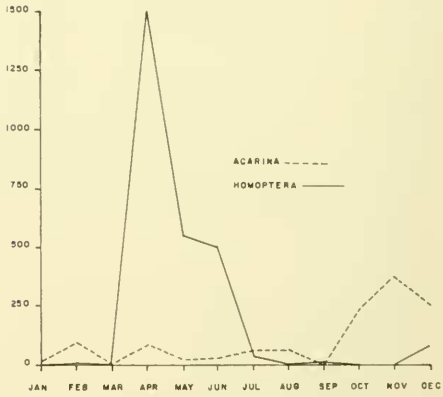

Figure 33. Seasonal occurrence of Acarina and Homoptera on *Kochia americana*.

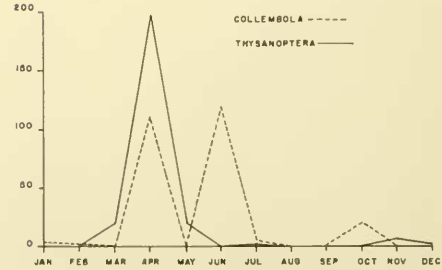

Figure 34. Seasonal occurrence of Collembola and Thysanoptera on *Kochia americana*.

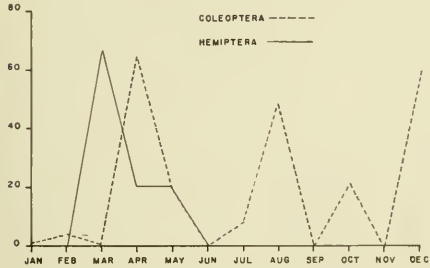

Figure 35. Seasonal occurrence of Coleoptera and Hemiptera on *Kochia americana.*

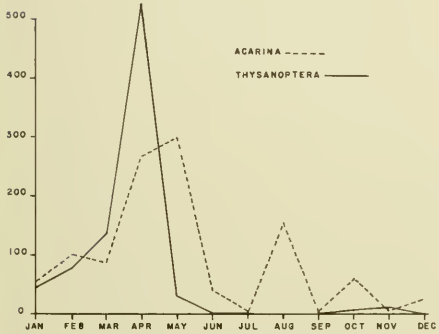

Figure 36. Seasonal occurrence of Acarina and Thysanoptera on *Larrea divaricata.*

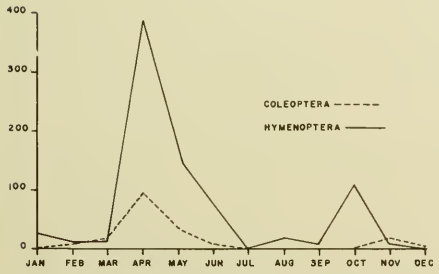

Figure 37. Seasonal occurrence of Coleoptera and Hymenoptera on *Larrea divaricata.*

Figure 38. Seasonal occurrence of Coleoptera and Diptera on *Lycium andersoni.*

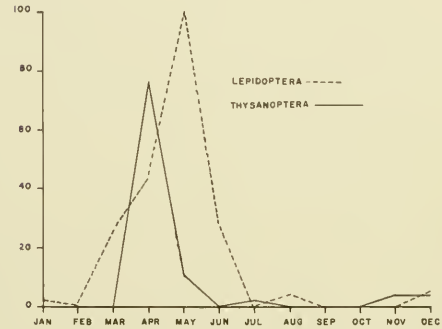

Figure 39. Seasonal occurrence of Lepidoptera and Thysanoptera on *Lycium andersoni.*

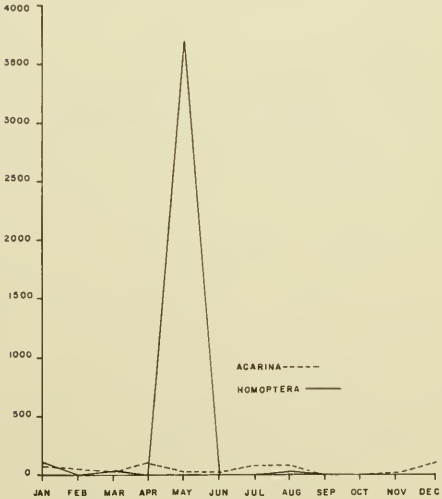

Figure 40. Seasonal occurrence of Acarina and Homoptera on *Lycium andersoni.*

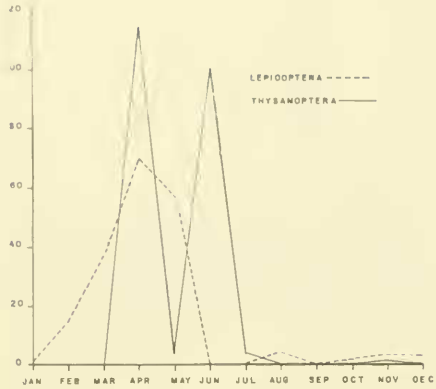

Figure 41. Seasonal occurrence of Lepidoptera and Thysanoptera on *Lycium pallidum*.

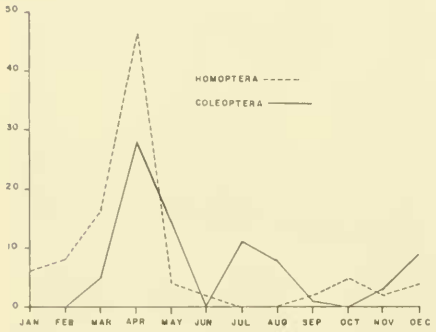

Figure 42. Seasonal occurrence of Homoptera and Coleoptera on *Lycium pallidum*.

Figure 43. Seasonal occurrence of Acarina on *Lycium pallidum*.

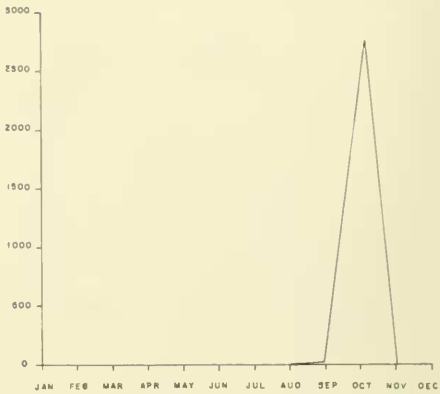

Figure 44. Seasonal occurrence of Hemiptera on *Salsola kali*.

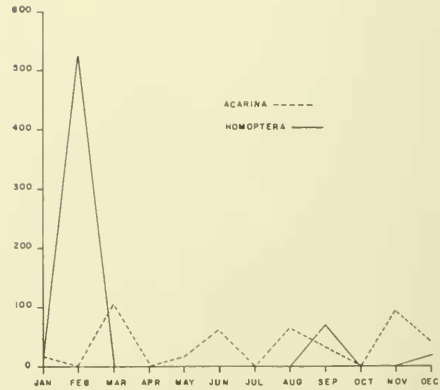

Figure 45. Seasonal occurrence of Acarina and Homoptera on *Yucca brevifolia*.

Figure 46. Seasonal occurrence of Diptera and Coleoptera on *Yucca brevifolia*.